Modelling the zonal drift of equatorial plasma irregularities and scintillation

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Outlines

- **Why is the zonal drift of plasma bubbles important?**

  The zonal drift determines the location of plasma bubbles after they are generated and is the key factor for predicting where scintillation will occur at a later time.

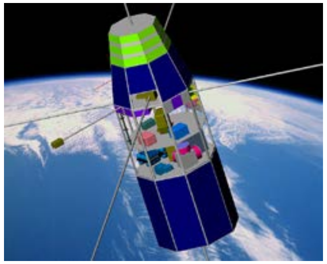
- **Data used to construct the model include:**

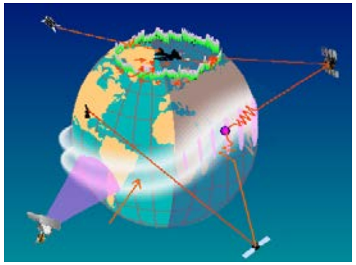
  plasma bubble drift measured by C/NOFS PLP

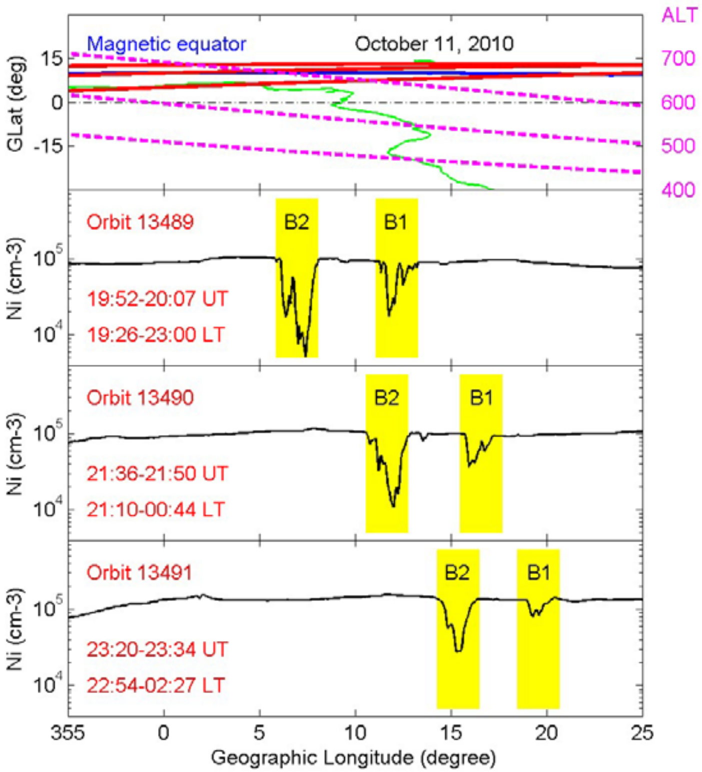
  plasma drift patterns measured at Jicamarca

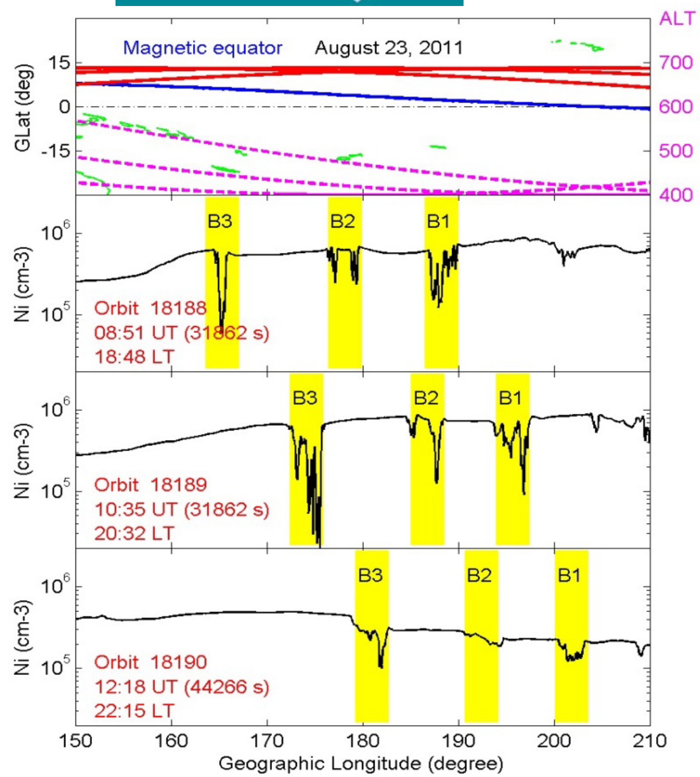
  other data

Example of the zonal drift of plasma bubbles: C/NOFS observations



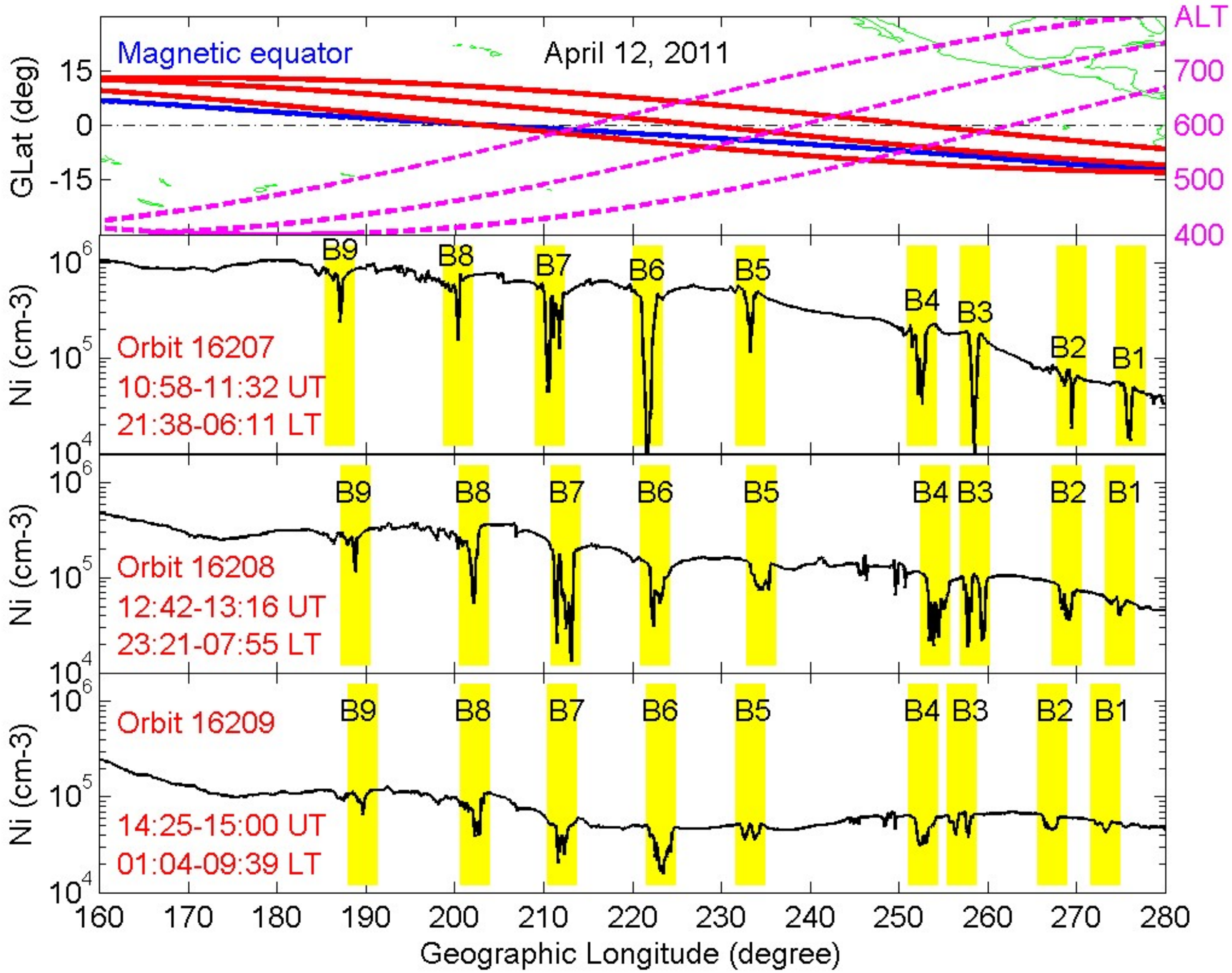






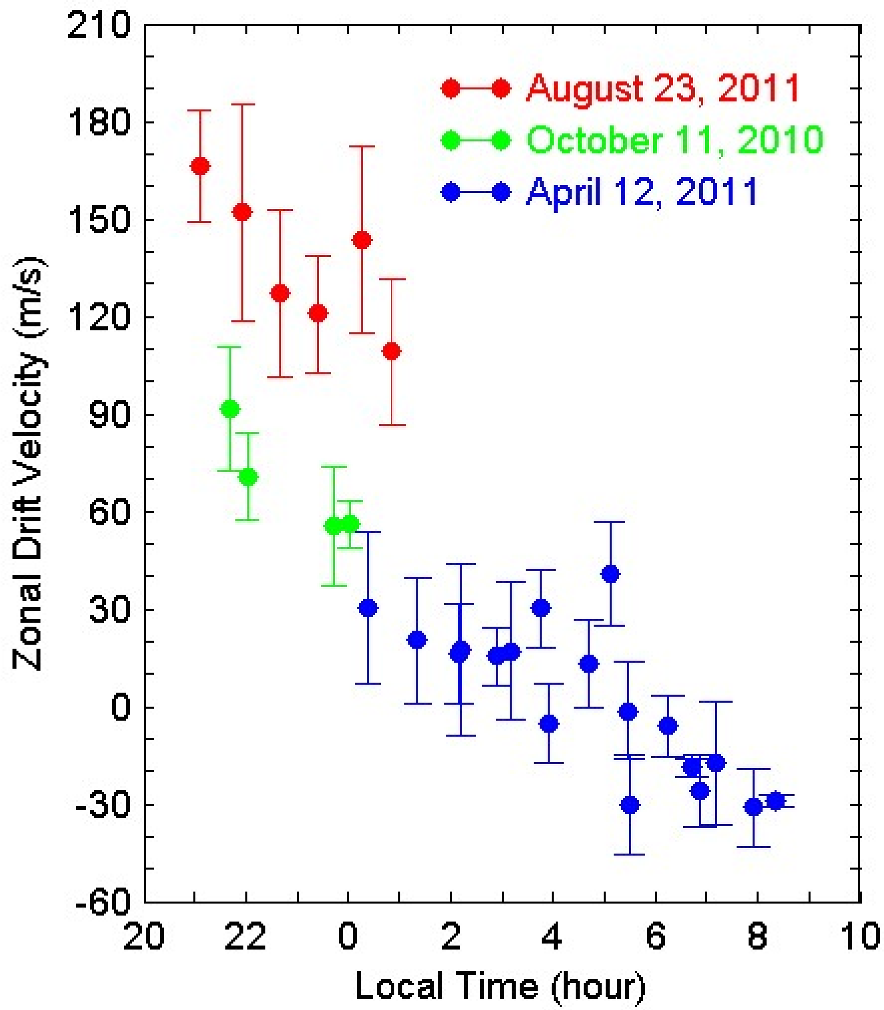
Plasma bubbles moved eastward from orbit to next.

Example of the zonal drift of plasma bubbles: C/NOFS observations



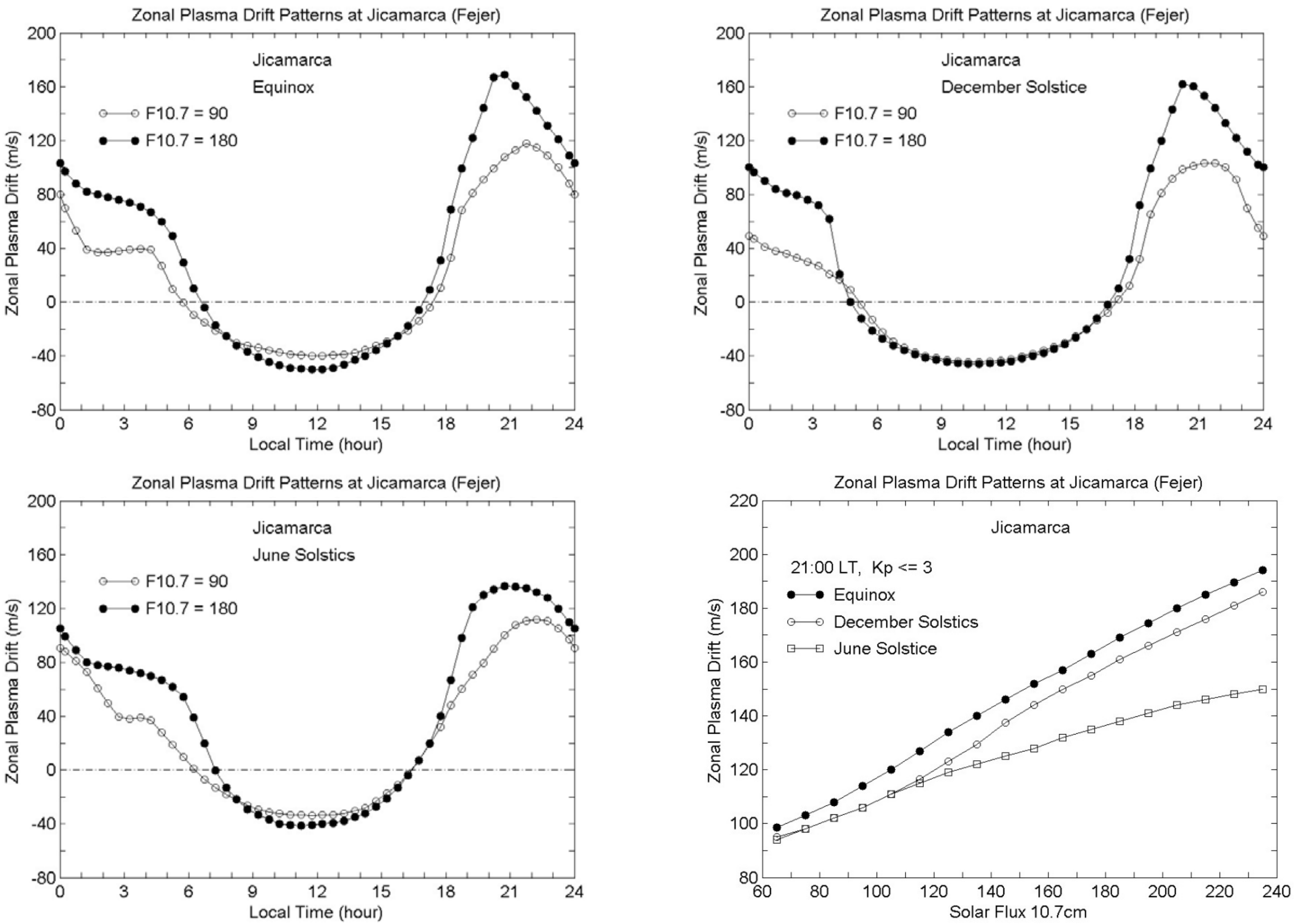
Plasma bubbles moved eastward or westward, depending on local time.

Zonal drift velocity of plasma bubbles: C/NOFS observations



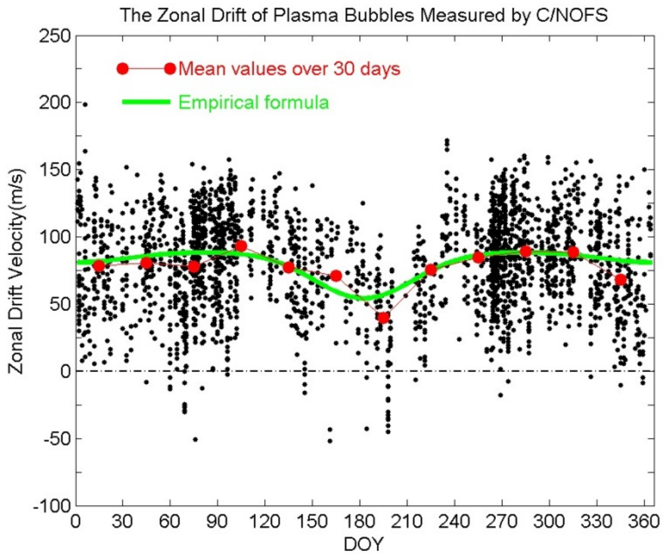
Bubble zonal drift is determined by the change in longitude between successive orbits.

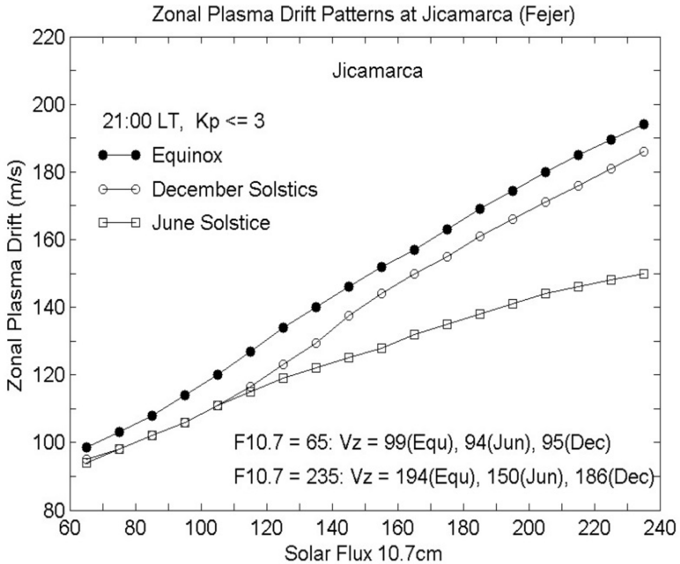
Average patterns of plasma zonal drift at Jicamarca

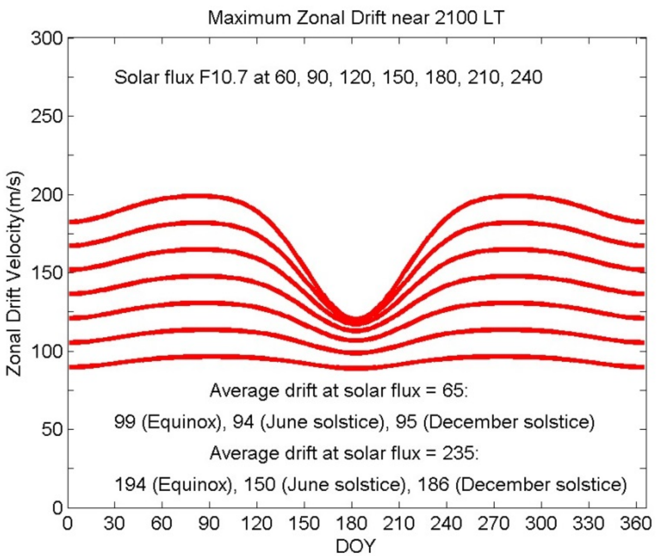


(Fejer et al., 2005)

Dependence of bubble drift on solar flux and season





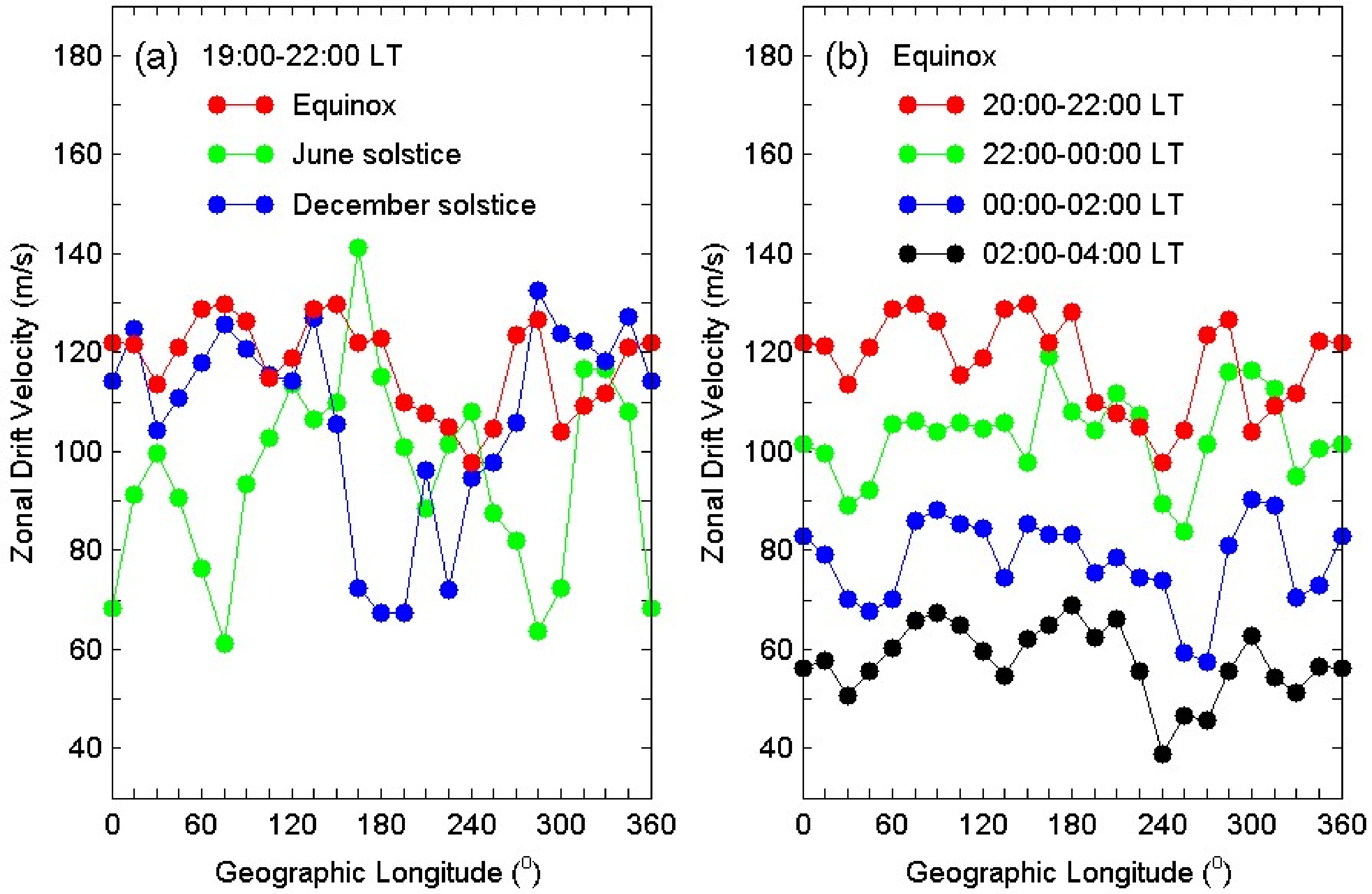


The daily variation of the zonal drift is determined from C/NOFS bubble drift data.

The dependence of the daily variation on solar flux is given by Jicamarca maximum drift near 2100 LT.

The seasonal mean values at solar flux=65 and 235 are the same for the model and radar data.

Dependence of C/NOFS bubble drift on longitude



Left: Bubble drift patterns for different seasons
Right: Bubble drift patterns for different local times

Features of the drift model

- **Model input parameters:**

  F10.7, DOY, Longitude, Magnetic Latitude

- **Model resolution:**

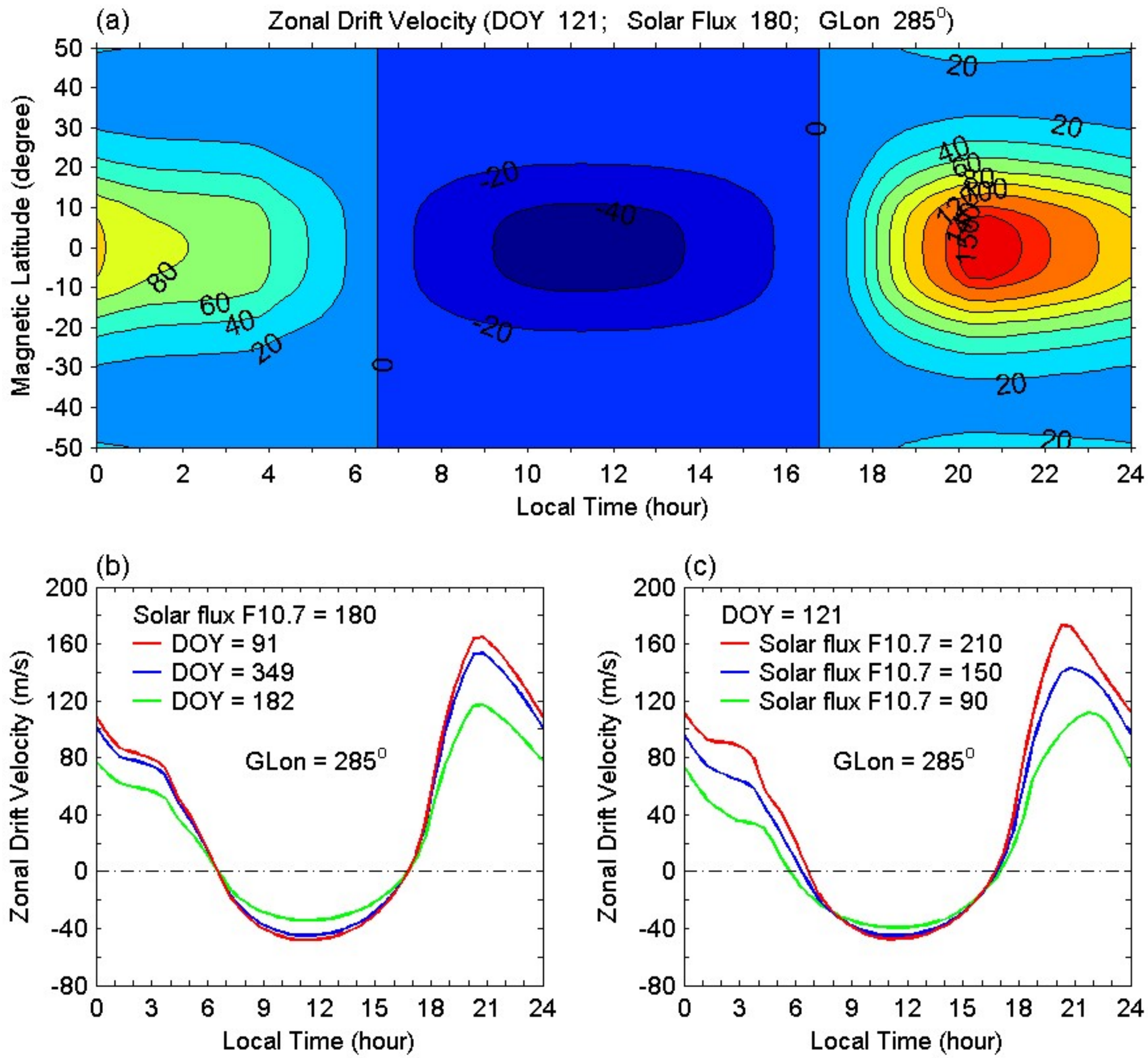
  Local time: 15 min; Longitude: 1^o; Latitude 1^o;

- **Model output:**

  LT distribution of the zonal drift

  2-D map of the zonal drift (LT- MLat)

Output of the drift model

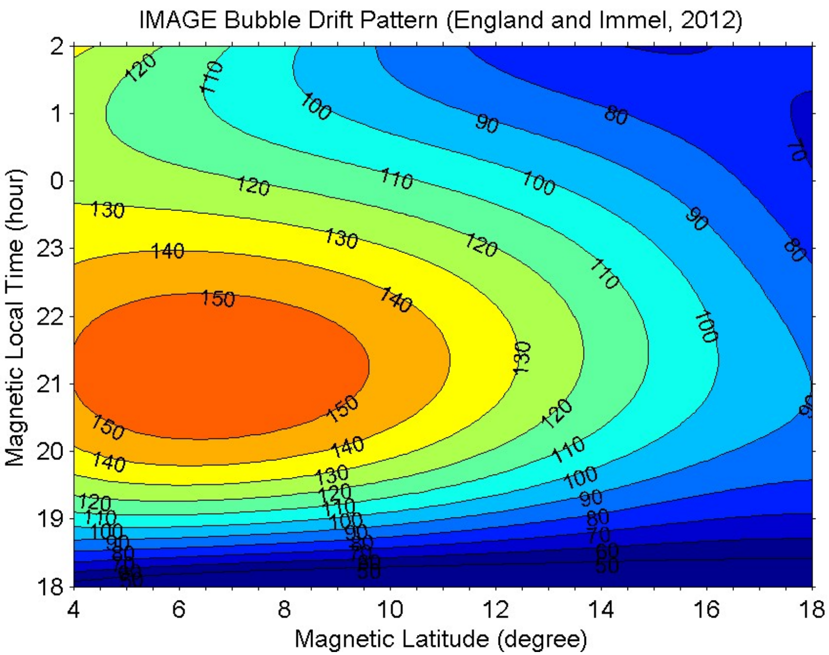


Daily variation:
The zonal drift of plasma bubbles is eastward at night and the largest near sunset.

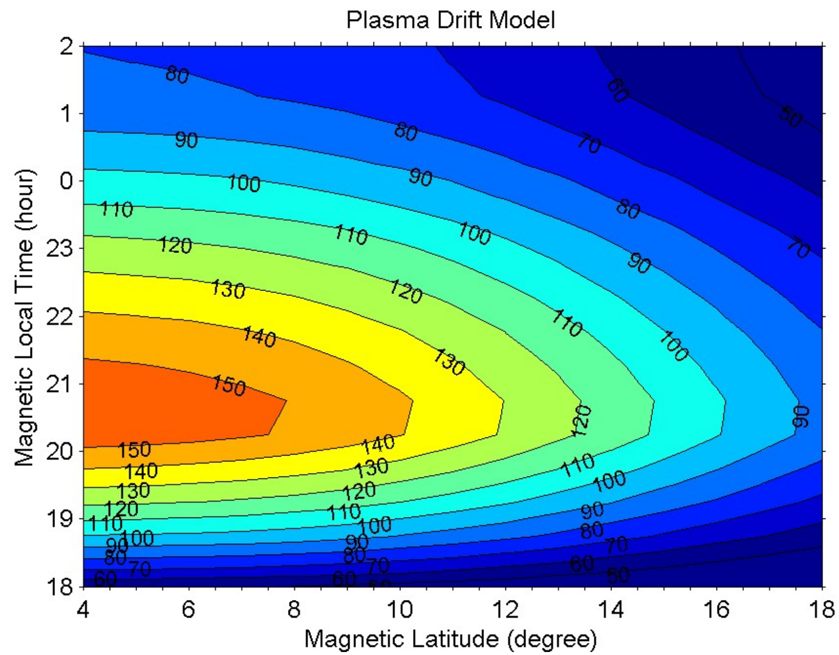
Dependence on season:
The zonal drift of plasma bubbles is large at Equinox and December solstice and small in June solstice.

Dependence on solar flux:
The drift velocity increases with solar flux, and the reversal of the zonal drift near dawn shifts towards later time with higher solar flux.

Comparison between the drift model and the IMAGE bubble drift pattern

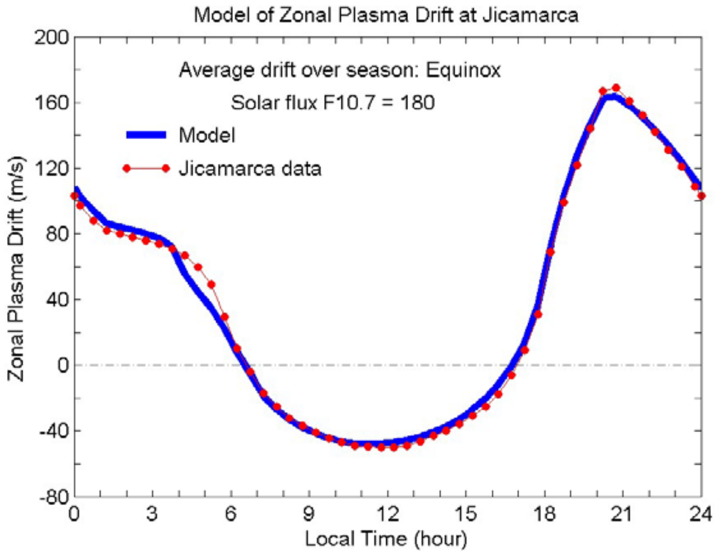


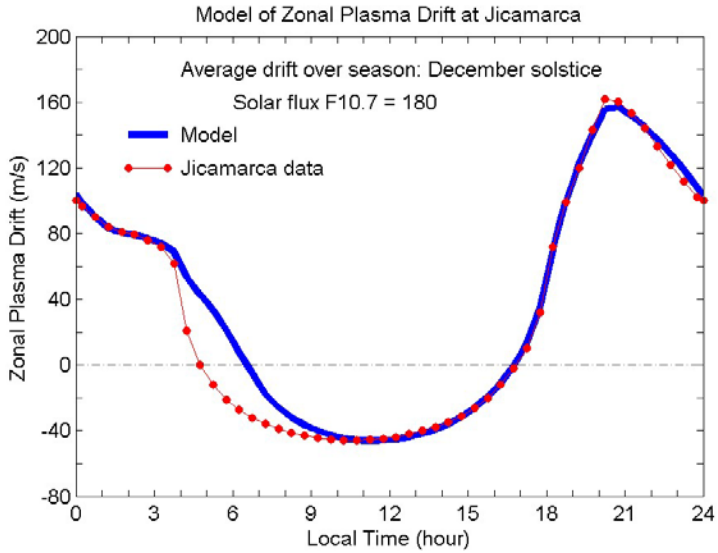
Plasma bubble drift based on IMAGE satellite observations (England and Immel, 2012)

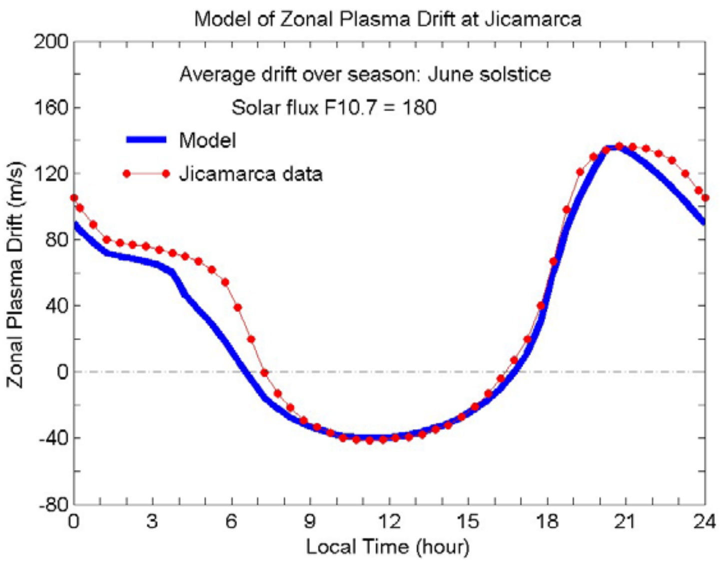


The LT-MLat variation of the drift model

Comparison between the drift model and Jicamarca drift patterns





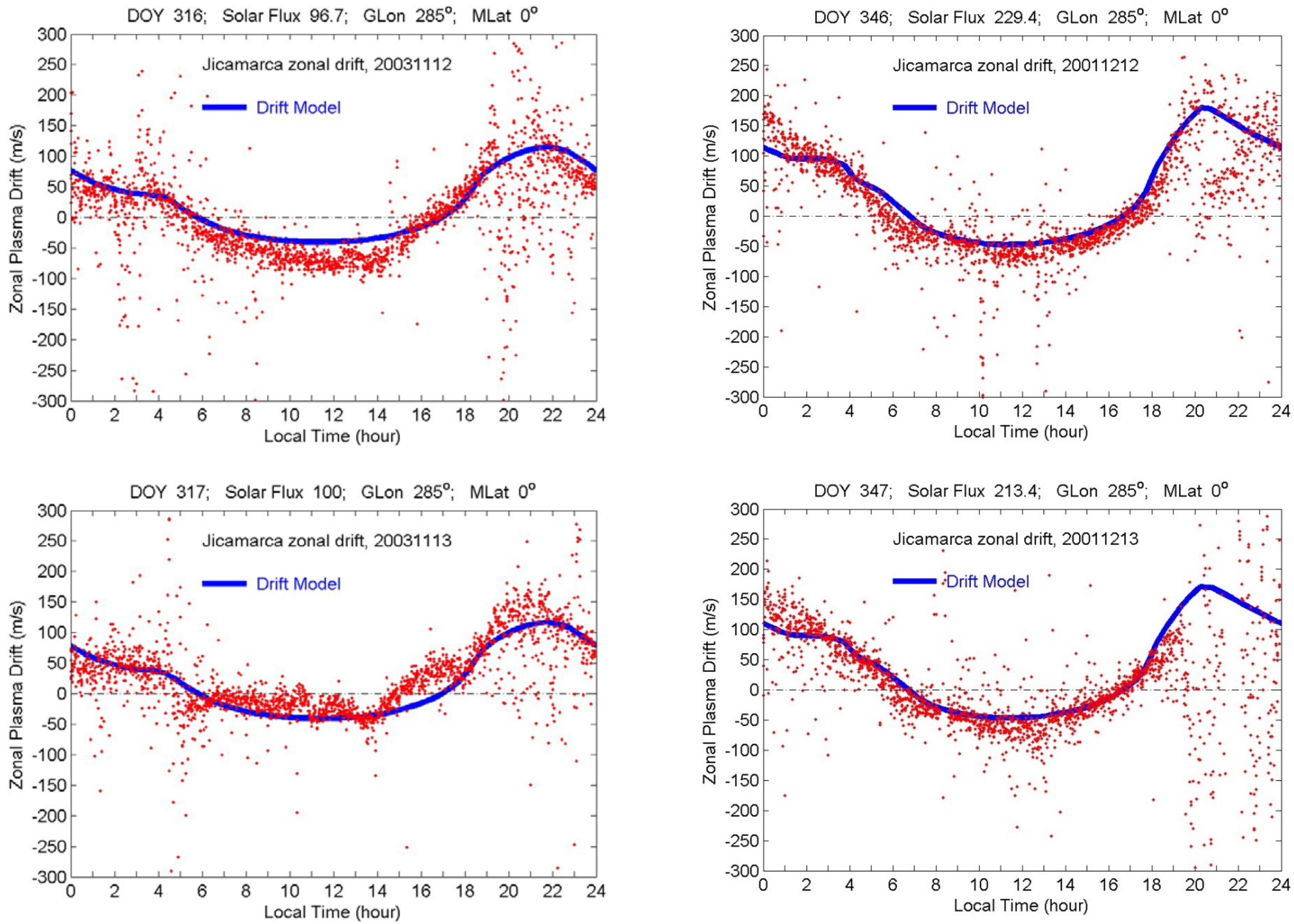


Solar flux level: F10.7 = 180

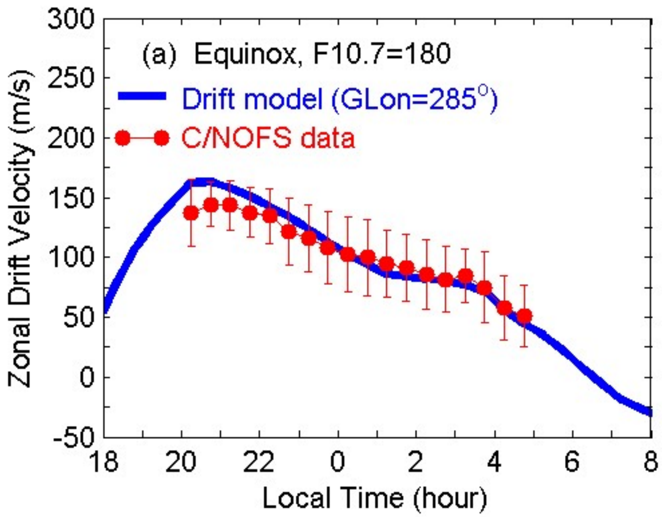
The Jicamarca data are the drift patterns for different seasons (Fejer et al., 2005)

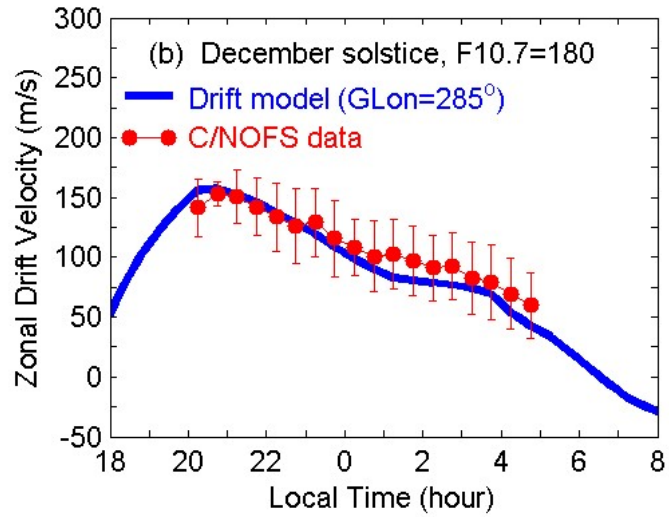
The blue lines are the model values averaged over each season.

Comparison between the drift model and Jicamarca drift: Randomly selected days



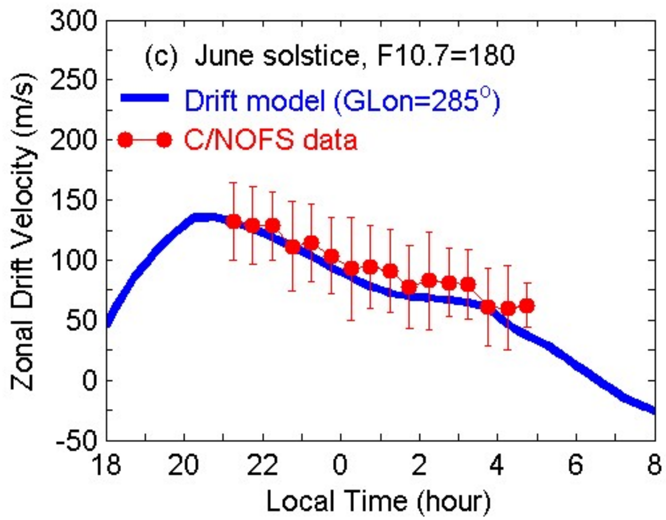
Comparison between the drift model and C/NOFS bubble drift patterns





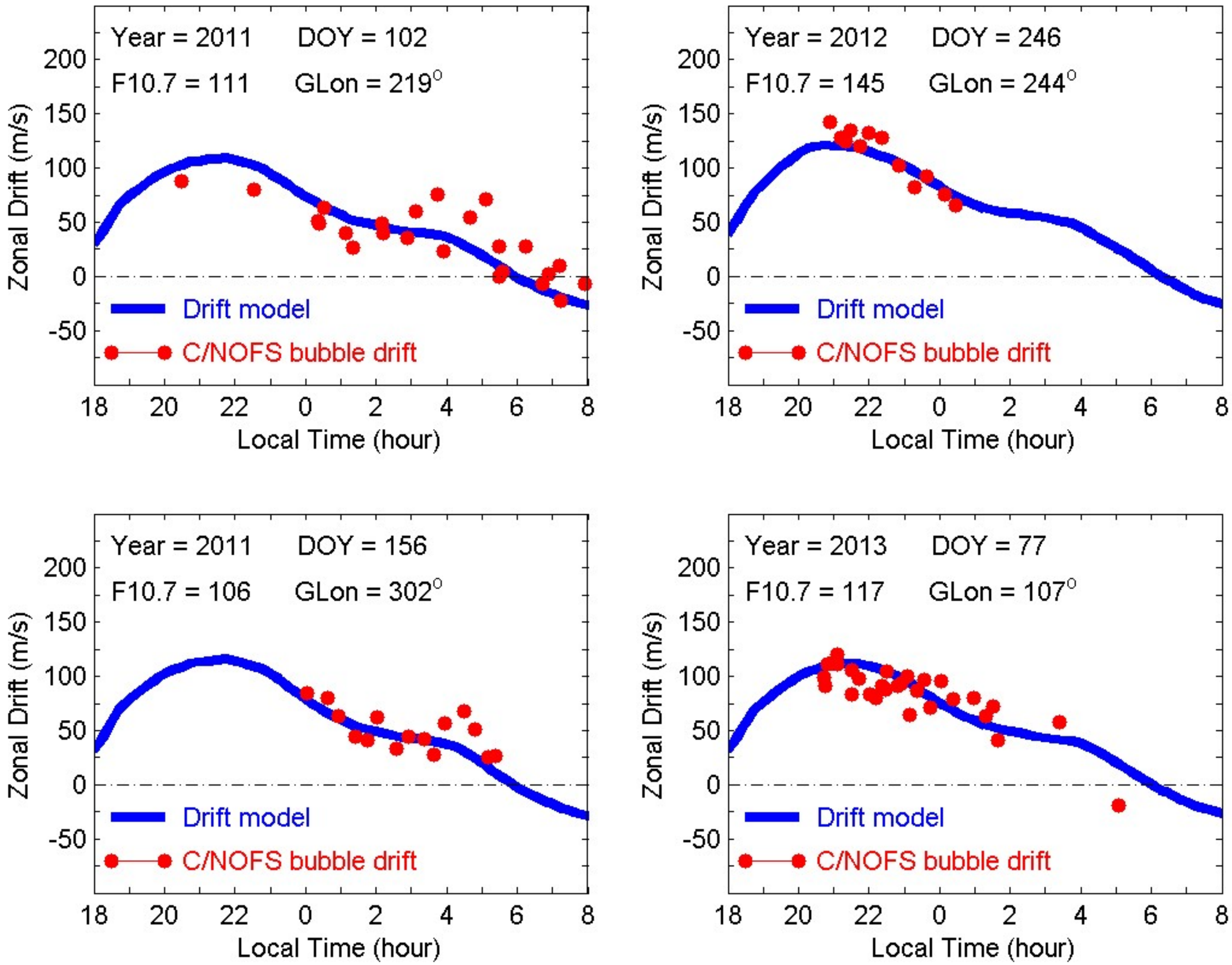
CNOFS bubble drift over 2008-2013

The red dots are the mean drift speed over 30 minutes.

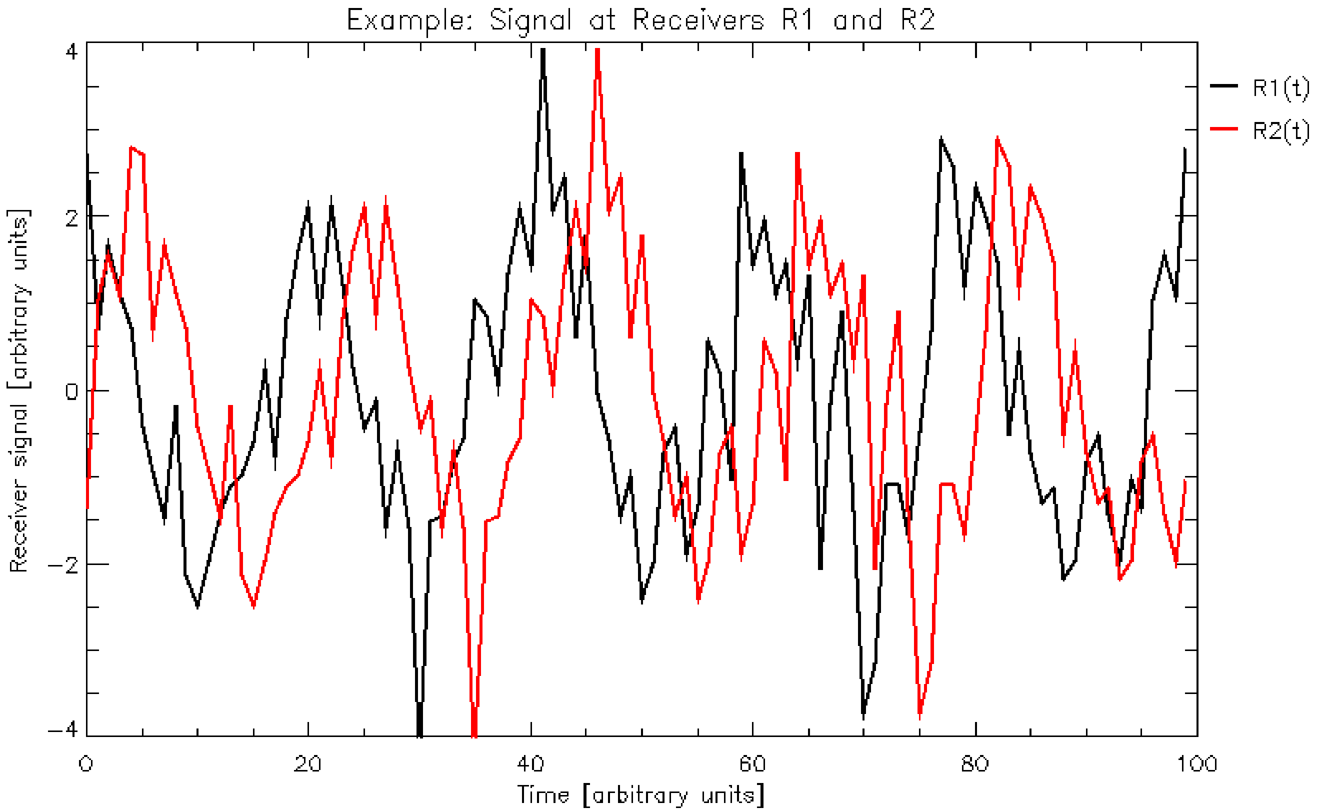


The blue lines are the mean values of the drift model over each season.

Comparison between the drift model and C/NOFS bubble drift: Randomly selected days

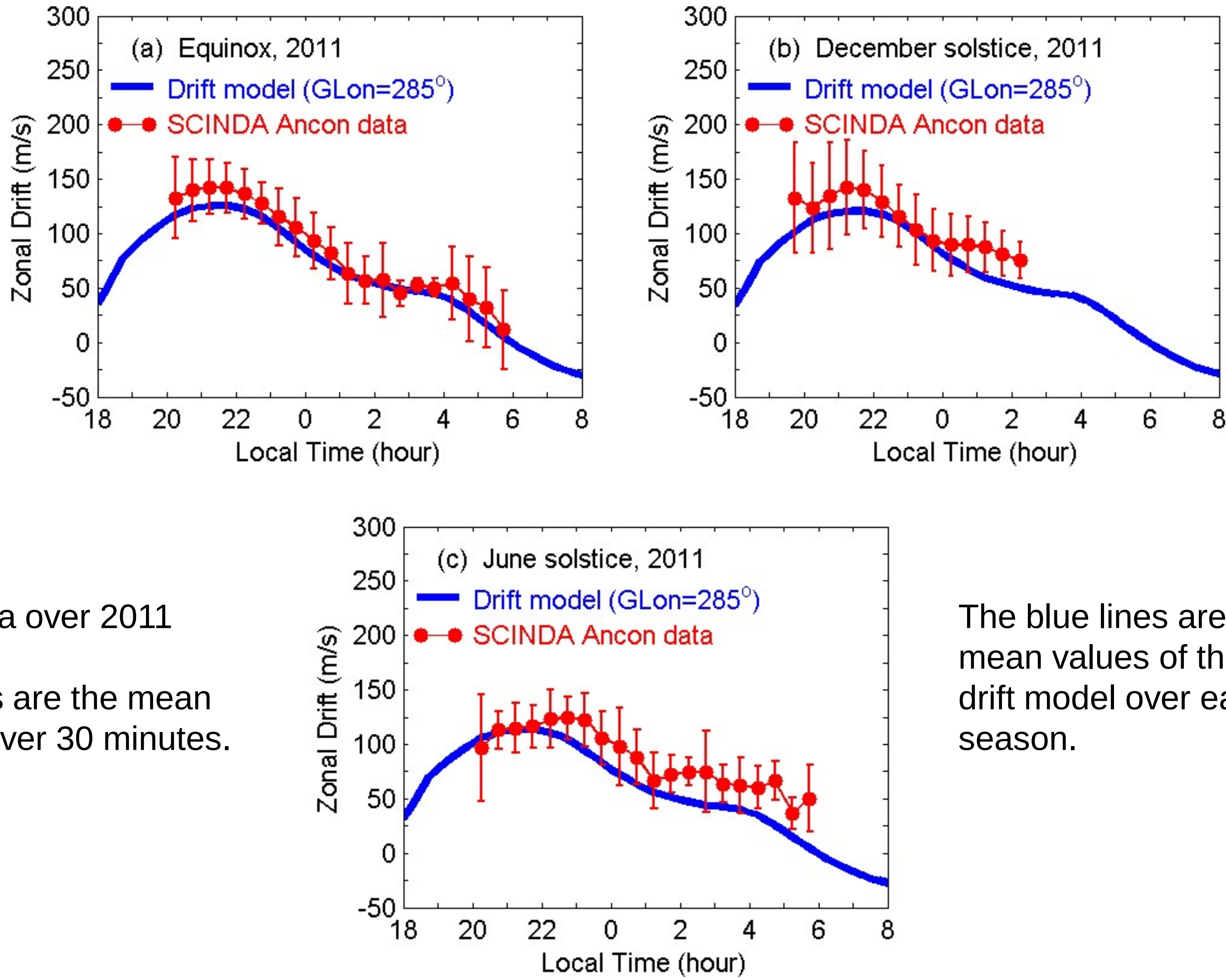


Example of the zonal drift of plasma irregularities measured by SCINDA UHF receivers



Example of time series from SCINDA UHF receivers R1 and R2, separated by 100 m. The signal at R2 is essentially identical to R1, just shifted by some time lag Δt.

Comparison between the drift model and SCINDA irregularity drift patterns



SCINDA data over 2011

The red dots are the mean drift speed over 30 minutes.

The blue lines are the mean values of the drift model over each season.

Summary

- **A preliminary model of the plasma zonal drift is constructed.**
- **Input parameters are:**

  DOY, solar flux F10.7, geo longitude, mag latitude.

- **Model outputs are:**

  LT distribution of the zonal drift

  2D map of the zonal drift (LT – MLat)

- **The model shows good agreement with Jicamarca drift patterns and C/NOFS plasma bubble drift.**